

Space Weather Technical Forecast

Issued on Thursday, 24 March 2022 at 12:36 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Daily Slight Chance of R1/R2 Minor/Moderate Radio Blackouts. Risk of Minor Geomagnetic Storm G1, probably peaking over UTC weekend.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with frequent low-level C-class activity interspersed with occasional larger C-class flares. The largest X-ray event of the period measured at GOES 16 was a C8.1, observed from AR2975 at 24/0145UTC, with this group generally proving most active. Having previously been described as one continuous region, further rotation has revealed that a pair of sunspot groups in close proximity may better describe the northeastern limb, with AR2975 now forming the leading cluster as a Cai/Beta, while the calved-off eastern portion now appears as a Dho/Beta. Much of the dynamism from the group is coming from the leading portion, with proliferation and spreading observed in AR2975 in the past 24 hours, with the trailing group more stable - perhaps partially masked by the poorer viewing angle. The only other sunspot group on the sun was the smaller and less complex AR2974 in the southeastern quadrant, with this finishing the 24 hours as a Cro Beta.

No Earth-directed Coronal Mass Ejections (CMEs) were observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind transitioned from a slow regime to fast in the 24 hours, with the speed measured at DSCOVR at L1 showing a gradual rise from background near 350km/s to become elevated, with eventual peaks near 575km/s. This is probably the onset of forecast CH67/+, with the phi angle accordingly positive for much of the period (away from the sun). The solar wind density was slightly elevated, generally residing near 10ppcc throughout, while the IMF peaked at 10nT, with a north-south range of +/-7nT. The Bz component was more often than not co-aligned with Earth's field to limit geomagnetic effects in the 24 hours, with provisional Kp peaking at 3+ in the 00-03UTC interval.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) measured at GOES 16 was at Background levels.

The high energy electron flux (greater than 2MeV) has been at Normal Background levels, and the 24-hour integrated electron fluence was well below the Active (1e8 integrated pfu) threshold, on a steady trend. Observed fluence at 24/0000UTC was 1.16e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: C-class flares are Expected in the period, with a daily Slight Chance of M-class. Further regions are also expected to rotate onto the visible disc over the next four days, with the outlook potentially seeing an increase in flare risk - the degree to which this occurs pending these arrivals for analysis.

Solar Wind / Geomagnetic Activity: There is a Slight Chance of G1 over the remainder of day

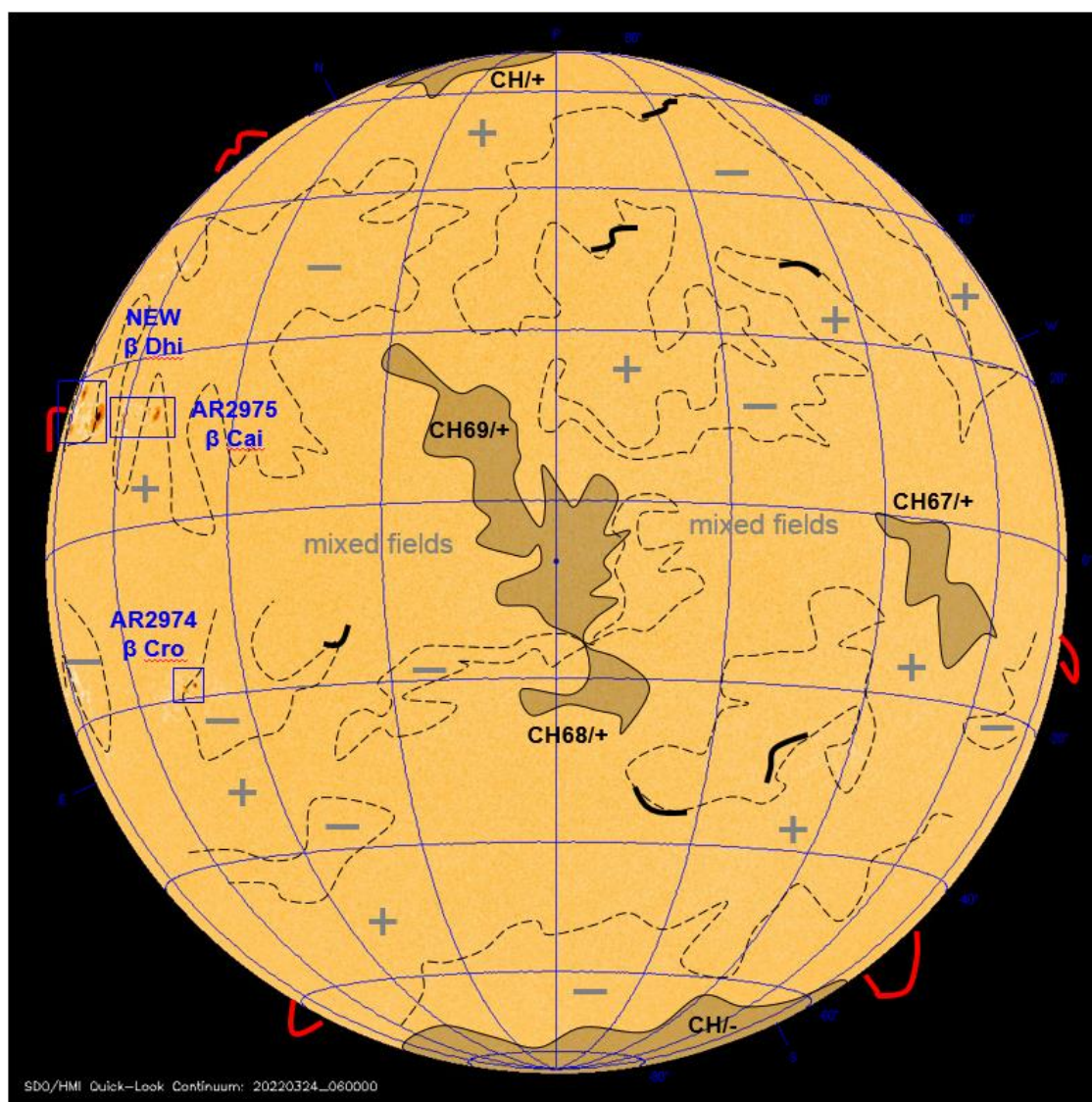
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one from the possible combined effects of the current CH67/+ and any peripheral 20 March CME, with the tail of risk continuing into Friday 25 March owing to low confidence in the CME especially. There should then be a short lull before a more assured Chance of G1 from CH68/69 later on day three, Saturday 26 March, continuing Sunday.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to be at Background levels throughout the forecast period.

The high energy (greater than 2 MeV) electron flux is currently at Normal Background levels, and is unlikely to increase in the near-term. The expected outlook for electron levels at GEO is now upward however, given the weekend coronal hole(s) in particular. Active fluence should perhaps eventually become 'odds-on' into the new working week UTC as a result.

Figure 1. Solar Analysis Valid 24/0600UTC.



Key: Filament ____, Prominence ____, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α - β - $\beta\gamma$ - $\beta\gamma\delta$ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There is one possible Earth-directed CME in the forecast, associated with the 20/0745UTC C4.6 flare which emerged from the plage remnant of Ex-2971 in the northeast quadrant. There is an according risk of a glancing blow at Earth, peaking today (Thursday 24 March), with some vestigial risk Friday. No other Earth-directed CMEs feature in the forecast.

Current coronal hole 67 appears to be nearing its expected peak magnitude in recent hours, and this has so far failed to impact significantly on geomagnetic activity. There remains a Chance of Active intervals especially in the coming hours, with the Slight Chance of G1 maintained largely as a result of any combined effects of this stream with the aforementioned CME.

The succeeding high speed stream from that observed at present is now manifesting at STEREO A, as of 24/0300UTC. This takes the form of a large but ill-defined doublet of coronal holes, with the southern portion (CH68/+) perhaps sectioned off from the northern (CH69/+) by a thin salient of negative polarity field in HMIBC imagery - the holes themselves appearing positive. With this satellite around 2.6 days upwind of Earth in the Parker spiral and sampling a very similar solar latitude, this puts forecast arrival later on day three, Saturday 26 March - earlier than previously advertised for lack of a recent forecast analog. The PLASTIC trace itself appears very noisy, however speeds in excess of 500km/s appear very likely, perhaps even approaching 750km/s, which would be a significant departure from last pass. While geomagnetic activity should peak shortly after onset, the fact that this is due to arrive later in this 24-hour window means that the risk of G1 is roughly equally partitioned as a Chance between the two UTC days of the weekend, probably then soon tailing off into the new working week.

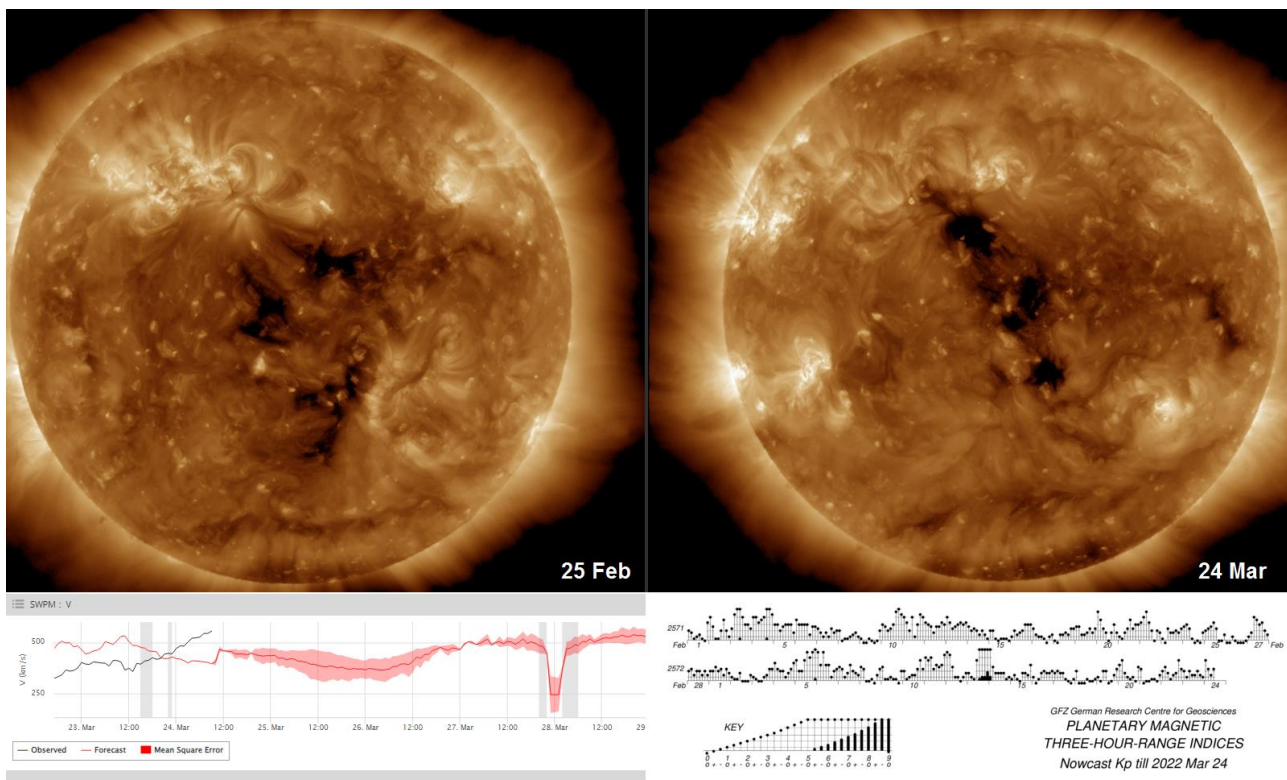
All considered, there is a Slight Chance of G1 from the possible combined effects of the current CH67/+ and any peripheral 20 March CME, with the tail of risk continuing into Friday 25 March owing to low confidence in the CME especially. There should then be a short lull before a more assured Chance of G1 from CH68/69 later on day three, Saturday 26 March, continuing Sunday before likely beginning to wane outside the scope of this forecast period. The most reliably favourable day geomagnetically is therefore day two, Friday 25 March.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	10	5	40	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
20/03/2022	Partial	Plage from Ex-2971	N09 E020	210km/s	24/2300UTC	Slow CME directed towards NE following C4 flare

Figure 2: Comparison of AIA 193 imagery between the past and current rotations, showing differences in geometry of the predecessor or CH68/69, but rough correspondence between its position on the disc. Recent STEREO A measurements of solar wind speed to between 500-750km/s perhaps imply that exceedence of past geomagnetic activity are likely, despite the positive polarity and proximity to the vernal equinox.



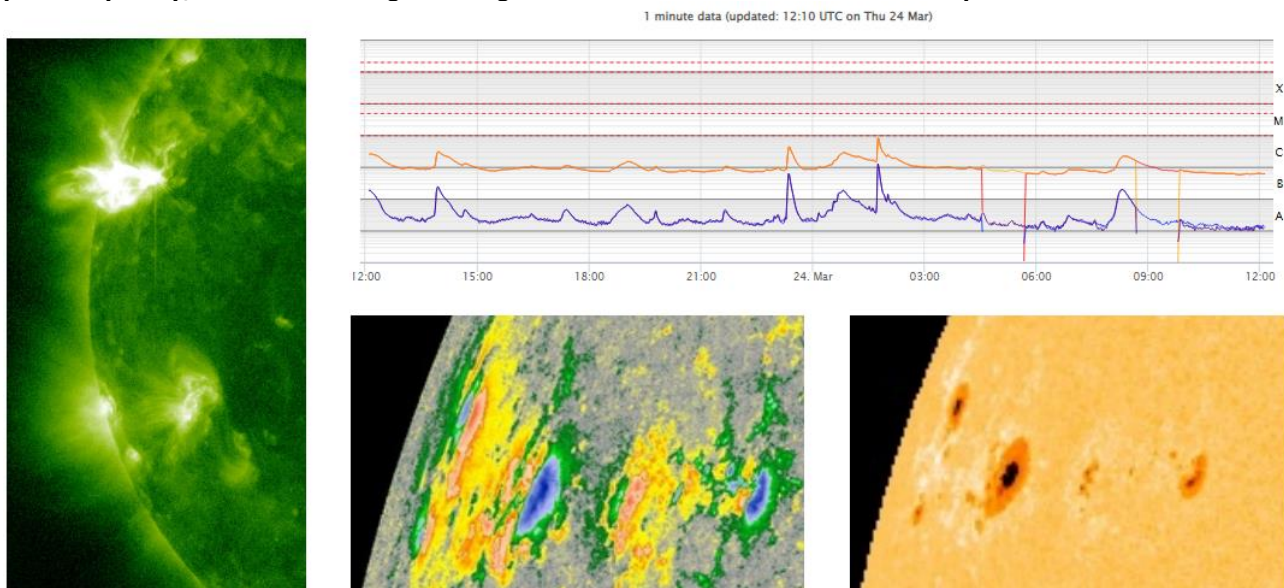
Radio Blackouts - X-Ray Flares:

There are up to three sunspot regions on the current solar disc, dominated in terms of activity and complexity by a long train of spots in the northeastern quadrant - a feature which now perhaps best resembles two separate regions. This quadrant is now quite starkly polarised in HMIBC, in strong contrast to the relatively diffuse western solar hemisphere, with activity strongly skewed to the former. This polarised character appears to continue onto the far side of the eastern hemisphere, which means that the expected trend in X-ray activity is upward in the four days, although the degree to which this occurs will be determined as and when any such regions show over the limb.

For now, C-class flares are Expected, with a daily Slight Chance of M-class that is dominated by the northeastern pair of spots.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	20	20	20	20
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: Clockwise from left: AIA 094 EUV image showing peak event of the past 24 hours – a C8.1 from AR2975; GOES 16 and 17 X-ray flux; HMIIF from 24/1200UTC showing AR2975 and its trailing portion (NEW); HMIBC showing the magnetic structure of the northeastern quadrant.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (10MeV) measured at GOES-16 is expected to remain at Background levels throughout the forecast period, with current sunspots clustered near the less well-connected eastern limb should any proton-rich flares be generated.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

High Energy Electrons Event (≥ 2MeV):

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The high energy (greater than 2 MeV) electron flux as observed at GEO by GOES-16 is currently at predominantly Normal Background levels.

The expected outlook for electron levels at GEO is now upward - the result of a succession of increasingly potent events that may include some or all of: CH67/+, the 20 March CME and then CH68/69/+. Despite this outlook, the 24-hour integrated fluence should remain below Active for the four days as an expected result of frequent bouts of geomagnetic activity and relatively short intervening quieter periods. Active fluence should become 'odds-on' into the new working week, probably more significantly so than on last rotation should the current behaviour of CH68/69 of 500-750km/s be repeated at Earth this UTC weekend.

The latest MOSWOC REFM available is now beginning to hint at an activity upturn in its latest forecast points, however this has yet to fully establish itself - offering instead a hint in the expected direction of activity, which is accepted.

GEO Electron Environment	Level (cm ⁻² sr ⁻¹ day ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1x10 ⁸	No	1	5	10	30
Very Active	≥ 2 MeV ≥ 1x10 ⁹	No	1	1	1	1



Figure 4: Top: past month in GOES 16 high energy electron flux, showing extended periods of Normal Background flux. Despite this, with forecast solar winds this UTC weekend between 500-750km/s, the trend from REFM can be expected to eventually be exceeded in its upward track.

